AN
INAUGURAL DISSERTATION
ON
PERSPIRATION;

SUBMITTED TO THE EXAMINATION
OF THE
REV. JOHN EWING, S. T. P. PROVOST,
THE
TRUSTEES AND MEDICAL FACULTY
OF THE
Univerſity of Pennſylvania,
For the Degree of
DOCTOR OF MEDICINE,
ON THE
Thirty-firſt Day of MAY, 1800.

BY JAMES AGNEW, *A. M.* K
Of Princeton, New-Jerſey;
Member of the Philadelphia Medical Society.

> "Simple Anatomy is a maſs of dead matter—It is Phyſiology which infuſes life into it."
>
> *Ruſh on Animal Life.*

Philadelphia:
PRINTED FOR MATHEW CAREY.
From the Preſs of *D. HOGAN*, N°. 51, South *Third-ſtreet*,
oppoſite the United States Bank.
1800.

BRITISH MUSEUM

TO

JOHN MACLEAN, M. D.

Profeſſor of Mathematics and Natural Philoſophy,

IN THE

COLLEGE OF NEW-JERSEY.

SIR,

YOU will not, I hope, consider this dedication as a matter merely of form, or an attempt to annex your patronage to a performance which may little deserve it. My intentions, I flatter myself, proceed from a more disinterested motive.——Gratitude requires, that I should thus publicly acknowledge the many instructions I have received from you, as well in the character of a friend, as that of my constant preceptor.

These, Sir, I shall ever gratefully remember, and consider it as a duty I owe you, in future life to appear to have deserved them. With the highest respect for your talents, and sincerest wishes for your happiness,

I have the honour to be

your Pupil and Friend,

JAMES AGNEW.

May 30*th*, 1800.

ON

PERSPIRATION.

OUR ſkins are frequently covered with a fluid, called ſweat. It has alſo been determined, by experiments which have been long known, that a fluid of a watery nature, but in a form commonly inviſible, is conſtantly eſcaping from our ſurface; and by others of a more recent date, it appears, that ſubſtances which, when uncombined, retain, at all known temperatures, an ærial form, are at the ſame time emitted.

Theſe are ſaid to be perſpired, the firſt by ſenſible, and the two laſt by inſenſible perſpiration.

They have been the ſubject of much diſcuſſion among phyſicians. Some have conſidered them as proceeding from a common ſource; while others have ſuppoſed them produced by different means. Many have eſteemed their emiſſion as eminently eſſential to health, while a few, particularly of late, have regarded their retention as harmleſs, or at leaſt of little conſequence.

In this diſſertation it is propoſed, to inquire into the foundation and ſupport of theſe different opinions, and, if poſſible, to decide between them. That this may be done, it is firſt of all neceſſary to be acquainted with the ſtructure of thoſe parts of the body from which they are emitted.

I. Of the external integuments.

Theſe are the cuticle, rete mucoſum, and cutis vera, to which may be added, the adipoſe or cellular membrane.

1ſt. Of the cuticle. It is a thin, tranſparent and inſenſible pellicle, cloſely joined to and connected with the ſkin. Its ſubſtance does not appear to be of a fibrous or vaſcular texture; but is uniformly continued and hard, in ſome meaſure analagous to the ſubſtance of which the nails are compoſed. On its inner ſurface it appears ſmooth and uniform, but on its outer it is covered with a great number of laminæ, connected in ſuch a manner as to give it a ſquamous appearance. Its denſity differs in different parts of the body. On the inner ſurface of the hands, the ſoles of the feet, and ſuch parts as are expoſed to the attrition of other bodies, it is thick and hard; while on other parts, ſuch as the cheeks and lips, it is exceedingly fine and tender. It adheres ſtrongly to the ſkin, but after it has been macerated for ſome time, or ſlightly putrified, they may be eaſily ſeparated. During their ſeparation, a number of white filamentary proceſſes may be ſeen paſſing between them; but which adhere to the cuticle when the ſeparation is completed. Theſe ſubſtances are tubular, and correſpond to ſmall pores or openings, which are diſtinctly viſible on the external ſurface of the cuticle, even by the naked eye, but more particularly by the aſſiſtance of a microſcope.—Different opinions have been entertained of its origin: Some have ſuppoſed it is produced by the matter exhaled, gradually hardening. Some, that it is the expanſion of the excretory veſſels, which are every where ſpread on the ſurface of the ſkin; and ſome, that it is by that of the nervous papillæ. But little is yet known of its true origin: one thing, however, is certain, that when abraded and deſtroyed, it is conſtantly and quickly re-produced.

2d. Immediately under, and adhering to the cuticle, is the rete mucoſum; which is a ſubſtance in general of a greyiſh colour, and reticular or net-like form. It is compoſed of the extreme branches of the capillary veſſels, which, after perforating the ſkin, are united and interwoven, forming meſhes like thoſe of a net, from whence it appears to have derived part of its name. When macerated in water, or ſuffered to putrify, it becomes of a ſoft, mucillaginous nature, ſeeming to be nothing more than inorganized matter, or mucus; and hence, probably, the term *mucoſum*. In the inhabitants of the torrid zone it is black, or of a darkiſh colour; but in Europeans it is more or leſs inclined to white. It is conſidered as the cauſe of the colour of the ſkin.

It is not generally agreed from whence this ſubſtance is derived; ſome ſuppoſing it to be formed of a humour exſuding from the true ſkin. But that it conſiſts of veſſels continued from the vaſcular ſyſtem, ſeems probable from the fact of bluſhing; for the colour beneath the cuticle at this time, is too general and diffuſed, to be attributed to veſſels leſs minute and extenſive than thoſe forming the rete mucoſum. Were not this vaſcular, but impervious to the blood, by intervening between the cuticle and the veſſels which convey the blood, it would, from its colour, prevent the red from being ſeen. The vaſcularity of the rete mucoſum, has been demonſtrated lately by the injections of Mr. Baynham of London. In inflammation alſo, a reticular texture of veſſels is to be obſerved on the ſurface of the ſkin. And although neither of theſe facts prove "theſe "veſſels, in a natural ſtate, to contain blood;" yet the force of circulation at ſome times may be ſo great, as to force into ſerous veſſels a quantity of red globules, and thus by affecting the veſſels under conſideration, occaſion that redneſs which we obſerve in bluſhing and in inflammation.

3. The cutis is the moſt interior of what are properly termed the external integuments. It is contained immediately within the cuticle and rete mucoſum, and is ſeparated from the muſcles by the fat and cellular membrane. It is ſtrong and flexible, eaſily admitting of extenſion in the various flexions of the body and limbs. It ſeems to be compoſed of numerous fibres, running in different directions. This texture is particularly obſervable in leather, and ſeems to form the body of the ſkin. It is covered on its exterior ſurface by little eminences, which appear like ſmall granulations, and are termed papillæ. Theſe are conſidered as being made up of the terminations of nervous filaments,

ments, together with thoſe of ſmall arteries and lymphatic veſſels. They have been deſcribed as of different figures in different parts. Thoſe on the ſoles of the feet, and in the hands, are moſt obſervable, being higher and more cloſely united; they appear to be diſpoſed in rows, forming lines either of a ſtrait, curved or irregular form, as on the ends of the fingers and toes. The ſkin is plentifully ſupplied by arteries and veins, which every where perforate and ramify through its ſubſtance, as has been fully demonſtrated by anatomiſts, by many fine injections. The arteries terminate here in very minute veſſels, which have been called the cutaneous capillaries. Theſe, after numerous ramifications, unite with their correſponding veins at angles, more or leſs acute, from which proceed veſſels called exhalants, as is proved by injections. And this appears to have been the opinion of Haller, when he obſerves, that the cutaneous diſcharge is ſecreted, "ex arteriis exhalantibus, quæ nullo medio "folliculo ex rubris arteriis naſcuntur. In vaſis perſpirationem cutaneam fundentibus injectio aquea vel glutinoſa tenuior ex arteriis ita exſudat, ut nullum dubium ſuperſit."* They terminate on the ſkin by open mouths, which receive into them the little tubes, projecting, as already mentioned, from the inſide of the cuticle.

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* Prim. lin. Par. 196.

Beſides the open terminations of theſe veſſels, and the pores of the cuticle, there are other openings in the integuments, viz. the mouths of the abſorbent veſſels, which, although inviſible, yet muſt certainly exiſt; as the abſorbents may eaſily be traced as far as the ſkin; and certain ſubſtances, when rubbed on the ſurface of the body, will be abſorbed and carried into the circulation. As connected with the ſkin, may be mentioned the hairs. Theſe are found in almoſt every part of the body. They ſeem to originate from a bulb, or root, ſituated between the ſkin and adipoſe membrane, and to perforate the ſubſtance of the ſkin.

In many places we find ſmall reſervoirs of ſebaceous matter, as about the noſe, ears, axillæ, &c. This is ſuppoſed to be ſecreted by glands ſituated in thoſe places, termed the ſebaceous glands. The exiſtence of ſuch glands, if not demonſtrated, is admitted in anatomical writings.*

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* New. Syſt. Anat. Vol. I. pag. 463.

II. The next inquiry propoſed to be made, is into the ſenſible and chemical qualities of the perſpired fluids.

And, 1ſt. Of the ſweat. It is of a watery form. is greaſy to the feel, and ſaltiſh to the taſte; it often has a peculiar ſmell, which, however, is different in health from what it is in diſeaſe. Beſides water, the ſweat contains other ſubſtances; a quantity of ſalt, which gives it the taſte, and an unctuous matter which remains on the ſkin, or is imbibed by the clothes, and which, unleſs it be wiped off, becomes filthy and unpleaſant. It is probable that the difficulty with which this ſubſtance can be waſhed off, has led to the invention of ſoap. The celebrated Dr. Mitchell of New-York, has ſuppoſed, "that alkaline and ſaponaceous mixtures "remove all greaſy ſubſtances, by virtue of "the ſtronger attraction they exert towards "them, than theſe for the cuticle or the gar- "ment worn next to it."* For my part, when I conſider that the adheſion of the greaſy matter to the cuticle, is not owing to any chemical union between them, and that alkalies form with oil a ſubſtance which is miſcible in water, I am inclined to attribute their effect in cleaning the ſkin, merely to their uniting with the fatty matter of the ſweat, to form a ſubſtance that may eaſily be waſhed off. The ſweat alſo frequently contains an acid. *Dr. Dobſon obſerved this in a diabetic patient; and ſuppoſed its appearance to be owing to a ſecretion of part of the chyle by the ſkin, and undergoing an acetous fermentation. This hypotheſis, however, admits of no proof. That chyle ſhould be received into the maſs of blood, and paſs through the circulation, without ſuffering a change, phyſiologiſts are dipoſed to deny. Mr. Berthollet affirms, that he found ſweat to redden blue paper, and concludes the acid thus diſcovered to be the phoſphoric.†

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* Med. Repoſ. Vol. III. N°. 2. pag. 165.

When the perſpired matter does contain acids, alkalies will neutralize them, and thus the effect of alkaline mixtures in cleaning clothes impregnated with ſweat, may be two-fold, the rendering the greaſe miſcible with water, and the neutralizing the acid. Dr. Mitchell is of opinion, that ſweat, or, at leaſt, that clothes which have been impregnated with it, contain occaſionally ſome nitric acid. This may be poſſible, but the proof which he adduces of it is not ſatisfactory. He ſays, that the ſailors in Weſt India voyages, for want of ſoap, frequently waſh

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* Med. Obſer. & Enq. Vol. V.

† Fourc. Elements, pag. 207.

their clothes with molaſſes, as a ſubſtitute for it; and he is of opinion that this acts by decompoſing the acid. But the molaſſes may ſerve to clean clothes, juſt as fullers' earth, meal, or bran, ſerve to clean wool, viz. by forming with the greaſe a ſubſtance which is miſcible with water.

Sweat is united in ſome parts of the body with the ſecreted matter of ſome glands; from this deriving peculiar qualities and appearance. Hence we find it more fetid in the groins, arm-pits, &c. where theſe glands are moſt numerous. After eating particular ſubſtances, or taking ſome medicines, their ſmell, as well as taſte, are ſometimes to be diſcovered on the ſkin. Even blood has been obſerved in the ſweat.

2d. Of the inſenſibly perſpired watery fluid.

The diſcovery of this diſcharge, though generally attributed to Sanctorius, who, from his experiments on it, eſtabliſhed many aphoriſms reſpecting the preſervation of health, is as ancient as Galen. That it was known to him, is evident from his own words: * "This excrementitious "vapour," ſays he, "is expelled through ſmall "orifices, which the Greeks call pores, diſper- "ſed all over the body, and eſpecially over the "ſkin,

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* De Sanit. tuend. lib. iii. cap. xii. ſub finem.

" ſkin, partly by ſweat, and partly by inſenſible " perſpiration, (adelos ais theſi diapnoe) which " eſcapes the ſight, and is known to few."

This emiſſion may be made evident by the following experiment: If a looking-glaſs be held near to a healthy body, it will, in a ſhort time, become covered with moiſture in the form of a cloud or miſt, which, uniting, will at length ſtand in drops on its ſurface.

It may alſo be detected by including part of the naked body in a glaſs veſſel, ſecluded from the air; in a ſhort time its inſide will become covered with drops, and at length a ſufficient quantity of moiſture may be obtained to be ſubmitted to examination. * Mr. Abernethy found it to be inſipid, and not perfectly tranſparent. On evaporating half the fluid which he had received, a ſlight cruſt was left on the glaſs, which was not ſalt, but had a burned ſmell. Cauſtic alkali, when added, had no effect on it. It however converted to a faint green the vegetable blue colour. Marine acid had no other effect on it, than precipitating a ſmall quantity of mucous-like matter. He alſo remarks, that in ſome obſervations he made on the water exhaled from the lungs, he diſcovered no ſalt, but he

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* Functions of the Skin, pag. 141.

he found mixed with it, a ſimilar mucous matter, which gave it ſome viſcidity. Mr. Cruikſhank, and others, have alſo inveſtigated this ſubject; but little elſe has been ſaid, that can be depended on. But if confidence may be had in the experiments mentioned, the qualities, at leaſt of the inſenſibly perſpired watery fluid, may be conſidered as in ſome meaſure known.

3d. Of the æriform or gaſeous fluid. The ſubject of this gas has occupied the attention of ſeveral writers, who have made nearly ſimilar concluſions.

Dr. Prieſtley, in attempting to inveſtigate the change produced in the atmoſphere, by animal perſpiration, declares it different from that produced by reſpiration. He therefore aſſerts, that that proceſs does not injure the purity of the air in the ſame manner with the latter. In this he is contradicted by the experiments of thoſe who have come after him.

Dr. Ingenhouſz obſerved air to be perſpired from both animals and vegetables; but did not attend much to its analyſis. He obſerves, however, that "it ſeemed partly fixed air, as it "was ſomewhat abſorbed by water." And the remainder he conſidered as unfit for reſpiration.

This matter was alſo ſlightly examined by Mr. Cruikſhank. He added lime water to the air which was the ſubject of examination, when, from the precipitation of the lime, he concluded the preſence of fixed air, and alſo remarked, that a candle burned dimly in it.

The qualities of the gaſeous fluid have been more directly attended to by Mr. Abernethy. In a courſe of experiments made by him, much time and pains appear to have been taken to accompliſh this end. * By receiving theſe gaſſes over mercury, he was enabled ſufficiently to examine them; and he obſerves, that on throwing up lime water, "two-thirds of the re-"ceived air was rapidly abſorbed; and on the "addition of nitrous gas to the remainder, "neither red fumes, nor any diminution in the "quantity of air took place." This experiment, he ſays, was repeated ſix times, with ſimilar reſults. He therefore concludes the air perſpired, to conſiſt of carbonic acid and azotic gaſſes. In one experiment, he made this laſt to be to the whole as one-fourth; and in another, more than a third. But in general he is of the opinion, that the proportion of theſe gaſſes, is two-thirds of carbonic acid gas to one of azote.

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* Experiment A. pag. 111.

Theſe experiments, although they cannot be conſidered deciſive as to the quantity of the gaſeous fluids, go a conſiderable way towards a diſcovery of their peculiar properties. Some objections, however, may be offered to the manner in which the experiments were made, as tending to create uncertainty in their reſults. For in thoſe where mercury is the medium, he could not attribute the air collected entirely to the ſource of perſpiration; as mercury is found to contain air, by immerſing in it any ſubſtance of a filamentous texture, the hairs, for inſtance, which cover the hand, from their capillary power, though particles of air will be attracted, and uniting into larger, will riſe to the ſurface, and thus may ſerve to characterize the gas which is to be analyzed. A ſimilar obſervation may be made with regard to thoſe made in water.

The collection of air from water is known to every one. It may be freed of its air by boiling; and by this means its power of abſorption is increaſed. In the experiments marked B.* Mr. Abernethy obſerves, that on introducing his hand into the water, particles of air appeared on it, which by agitation were detached, and aſcended. But retaining his hand there for ſome time, no more air was produced. On repeating the experiment frequently, and changing the water, much greater quantities of air were obtained. When warm water was uſed, little or no air was produced. The water then, in this caſe, appears to be one ſource from which it is derived; and although the air collected, in every inſtance, cannot be aſcribed to this cauſe, nor its properties produced by the media made uſe of, yet its influence, in altering the proportions, and poſſibly the qualities of the contained air, muſt be conſiderable.

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* Pag. 114,—117.

III. The third general enquiry, which is now to be made, is the quantity of the fluids emitted: 1ſt, The quantity of ſweat is different at different ſeaſons; warm weather increaſing, while cold leſſens its diſcharge. There is naturally not ſo much, therefore, in winter as in ſummer: but though it does not ſtand upon the ſkin, there is always enough to impart to it a diſagreeable taſte and ſmell. This is a circumſtance well known to thoſe who wear flannel next their ſkin. For unleſs cleanlineſs be much attended to, the ſhirt, after becoming ſaturated with the ſweat, will be found frequently covered with a layer of greaſe: the ſame may be often obſerved on the cuticle. When the temperature of the air approaches nearly to that of the human body, the quantity of ſweat becomes more conſiderable. This is particularly to be obſerved after much exerciſe is uſed; it then ſtands in drops on the ſkin; and labourers, reapers, &c. who are expoſed commonly to the combined influence of theſe powers, frequently perſpire ſo much as to be able to wring out large quantities from their ſhirts.

In many diſeaſes alſo, the quantity is very conſiderable. There are many inſtances on record, as well as ſome which have come within our own obſervation, of ſweats ſo large as to cauſe aſtoniſhment. *Dr. Willis mentions the caſe of a lady, whoſe ſweats were ſo prodigious, that baſons were placed between her thighs to receive the humour which trickled down them. †Hoffman alſo, ſpeaks of an old man ſubject to continual ſweats, which proceeded to ſuch a degree, "that his whole nouriſhment "paſſed off by his pores." Similar inſtances might be cited from many more of the old writers. But caſes of ſweats, equally ſurpriſing, have been noticed by writers of a later date. ‡Darwin relates ſeveral of this kind; one in a gentleman affected with a dyſpnoea and ſwelling of the legs, when "ſo copious a ſweat came out "from

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* De Diaph. nimia. & depravata, ſect. 5. cap. iii.

† Turner de Morb. cutan. pag. 84.

‡ Zoonom. Part I. pag. 360.

" from his head and neck, that in a few hours " ſome pints, by eſtimation, were wiped off " from theſe parts." Two others he mentions, of ſweats ſo profuſe as to " deluge the " bed" on which they lay.

Fevers moſtly terminate in ſweats; and theſe are generally more or leſs profuſe, according to the violence of the force of circulation in the preceding paroxyſm. Theſe are ſubjects of common obſervation, but in ſome inſtances they go to greater exceſs than in others. Every one who has been in any meaſure acquainted with the autumnal intermittents of this climate, muſt have particularly remarked this. Solitary inſtances may alſo have been obſerved, by many perſons, of ſweats not leſs copious than have been related. Such a caſe I witneſſed laſt autumn, in a man affected with the epidemic of that ſeaſon. In him the ſweat was ſo prodigious, as to ſtand in his hair, and on his temples, in the form of a foam, and the blankets which covered part of his body, exhibited the ſame frothy appearance. On his neck and breaſt, which were expoſed, it was condenſed, not in drops, but ran in ſtreams down his ſides, completely wetting the bed below him; and (to mention a circumſtance which ſhould have been noticed when treating of the qualities of ſweat) the bile (probably) was perſpired in ſuch quantity as to colour that part of the bed on which he lay, with a deep yellow.

On the exhibition of certain remedies too, the emiſſion is often exceedingly profuſe. And the uniform effect of ſome articles, in promoting this end, ſtill retains to them the title of ſudorifics.

2d. To aſcertain the quantity of the inſenſible perſpiration, numerous attempts have been made, by many curious inveſtigators.

Sanctorius was the firſt who propoſed the diſcovery of this diſcharge, by calculations drawn from a reference to the balance. By weighing the aliment taken in a given time, and by the ſame method aſcertaining the weight loſt by the body in the ſame time; he determined the loſs through this channel to be equal to five eighths of the food taken in, or all the other excretions taken together.

As the difference of climate, however, occaſions conſiderable variety in the quantity of perſpiration, the reſults from experiments, in different countries, muſt vary; convinced of this fact, ſeveral phyſicians have purſued a courſe of ſtatical experiments, in order to diſcover the proportion of the ſenſible and inſenſible evacuations in the country in which they lived. For this purpoſe were made the obſervations of Dodart, Keil, De Gorter, Rogers, Linen, Bryan, Robinſon and Abernethy. None of them, however, appear ſufficiently accurate. Sanctorius makes the inſenſible diſcharge too great. He ſuppoſes all the vapour emitted from the lungs to be perſpired, whereas ſome of it probably may be formed by the union of the oxygen of the atmoſpheric air with the hydrogen of the blood in the lungs. Part of the loſs ſuſtained, is to be attributed to the waſte of the matter, which, together with the oxygen of the atmoſphere, forms the carbonic acid gas emitted by the lungs. As thoſe who treated this ſubject after him, made their experiments in the ſame way, their reſults appear equally inaccurate.

Abernethy makes it too little: the manner in which his experiments were made, renders the ſum perſpired, liable to great uncertainty. *He uſed "a glaſs jar covered with a wetted "bladder, in which an aperture was left, "through which he introduced his arm, around "which the bladder was tied; ſo that the "aſcent of any vapour was prevented. In "ſix hours he procured nearly three drams of "limpid taſteleſs water." He calculated the diſcharge which ſhould take place, from the whole

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* Experiment, pag. 134.

whole body, ſuppoſing it equal in all parts, by comparing the ſurface expoſed in the experiment, with that of the whole. This was done, by covering his hands with ſlips of paper, and meaſuring their extent. The reſult, by this method, muſt be too ſmall; for he could not, in this way, find the true ſurface of the hand, as the fingers are not perfectly cylindrical, but irregular, containing cavities and angles, from whence the perſpiration is more perceptible than from other parts. The reſult, therefore, being leſs in this part, the ſum or total diſcharge will be proportionably ſo. The total diſcharge, according to his calculations, was only two pounds and a half in a day, the temperature of the air being at 65°. But it would amount to conſiderably more, for in Mr. Abernethy's experiments, we muſt remember, that he ſuppoſes the perſpiration not only equal over the body but through the day; and as his exerciſe and temperature was at that time leſs than if he had been making the ordinary exertions of a man in health, he made no allowance for the greater quantities perſpired from theſe cauſes. The experiment on which the above calculation depends, is liable to an objection—the air included in the veſſel would ſoon become ſaturated with moiſture, and thus there would be preſented to the mouths of the abſorbent veſſels of the ſkin, a quantity of a watery fluid, which they would readily abſorb; whereas, in the ordinary ſituations of the body, the moiſture is either ſucked up by the clothes, or diſſolved and carried away by the air. Thus, the quantity emitted from the ſkin muſt be conſiderably more than he ſuppoſes. It will be difficult, however, from theſe circumſtances, to aſcertain it exactly.

3d. Many reſults have been given by Mr. Abernethy, of the quantity of the æriform perſpiration, but the greateſt appears to have been about an * half ounce meaſure in ſixteen hours, from the ſurface of the hand and wriſt, computed at ſeventy ſquare inches, which is, at that rate, not an ounce in a day, or twenty-four hours. This may be leſs than the ſum diſcharged, as, according to another ſet of experiments, a great abſorption was found to take place. It was found, by expoſing the hand to different proportions of air, inſulated in a glaſs veſſel, that this air, inſtead of receiving an increaſe, was conſtantly diminiſhed; the qualities of the remainder, however, being in ſome meaſure changed by part of that which was abſorbed being ſupplied by a portion diſcharged. The air abſorbed, was obſerved to be more or leſs, according to the purity of the air contained.

IV. The

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* Experiment A. pag. 113.

IV. The origin of theſe fluids is the next inquiry I ſhall make on this ſubject. Sweat, and the inſenſibly perſpired fluid, according to the opinions of the old writers, were not only different in their properties, but differently produced. The latter, they believed to be nothing more than a watery vapour, ſimply exhaled from the ſerum or finer parts of the blood, as no longer neceſſary to the health or growth of the animal. This they ſuppoſed was effected by veſſels continued directly from the arteries to the ſkin, and therefore as conſtantly in action, as the arteries themſelves, or the heart from which they are derived. This kind of perſpiration they thought was not of temporary duration, but conſtantly taking place, unleſs prevented by diſeaſe. Hence the great attention of the followers of the humoral doctrine to the ſtate of the ſkin, and the matters perſpired. By the action or want of action, in theſe veſſels, they pretended to explain the criſis, cure, or fatal termination of diſeaſes.

But ſweat they conſidered as conſiſting of a greater number of principles, and as being ſecreted from the blood for different purpoſes. The organs of this ſecretion were glands, which, from their ſituation beneath the external ſkin, were termed ſubcutaneous, but from their figure, miliary glands. From theſe ſubſtances it was conveyed by excretory ducts, which, perforating the rete mucoſum, diſcharged it through minute pores in the cuticle. To each of theſe pores they imagined a ſcale or covering to be affixed, which, from, its ſhape and ſituation, was to act as a valve, to retain or permit the paſſage of the fluid at pleaſure. Many deſcriptions have been given of the figure of theſe ſcales; but Liewenhoeck, by the aſſiſtance of his glaſſes, claims greater accuracy than any who have written on this fanciful ſubject. He obſerved them to conſiſt of "five "ſides, and lying over each other like ſcales "on a fiſh, * giving an uniform appearance to "the ſkin and the † white colour which exiſts "in moſt parts of the body." Around theſe ſcales were arranged the pores by which the inſenſible diſcharge was emitted. This variety in the veſſels which were ſubſervient to perſpiration, according to Boerhaave,‡ was admitted by the ableſt phyſiologiſts of thoſe times. With reſpect to the uſe of glands, however, in the production of ſweat their neceſſity was by ſome denied. Ruyſh would not admit their exiſtence, and in oppoſition contended for that of mere follicles for the purpoſe. Malpighi maintains the former opinion, and pretends to have demonſtrated the glands. But

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* Arcan. Nat. tom. i. part ii. pag. 47. † Ibid. pag. 51.

‡ Boerhaave's Lectures.

But notwithſtanding they differ on this point, they both ſuppoſe a difference in the nature of the cutaneous evacuations. From the deſcription they have given of the veſſels concerned in inſenſible perſpiration, they ſeem neceſſarily to ſuppoſe it directly emitted from the blood; yet the admiſſion of glands and excretory ducts in the production of the other, would induce us to believe they conſidered it a ſecretion. But the truth of either of theſe theories can only be eſtabliſhed by the diſcovery of ſuch glands, or follicles, as have been ſuppoſed by their propoſers. On this head, however, we have little ſatisfactory evidence, for notwithſtanding all that may have been ſaid by Ruyſh and Malpighi,* "it is certain that no diſtinct glands or "follicles can be traced by the knife."

That the matter of perſpiration is diſcharged by different veſſels, is further rendered improbable, by no veſſels having been diſcovered, by injections or otherwiſe, which originate from the ſanguiferous ſyſtem, except thoſe which have already been deſcribed when treating of the ſkin.

Both muſt be conſidered as originating from the blood; for as this is the ſource from which every ſolid, as well as every fluid which compoſethe animal body, is derived, to it muſt theſe and every ſecretion be attributed. In it are contained all the principles of which the perſpirable matter has been diſcovered to conſiſt: "* Qui cogitavit in ſanguine reperiri ſerum co-"agulabile," ſays Haller, "aquam exhalantem, "mucidum aliquod viſcidum, oleum denique, "incipiet percipere, potuiſſe omnino fieri, ut "hujuſmodi liquores, ex ſanguine ſepararentur "ut qui principia ſua in maſſa ſanguinea ha-"beant." In order then to underſtand the production of the perſpirable fluids, it is neceſſary to take into conſideration the circulation of the blood, and its conſequent diſtribution into the different veſſels capacitated to receive it. The heart being endued with the principle of irritability, contracts when irritated by the blood, and forces it into the arteries; and theſe being poſſeſſed of the power of contractility, derived partly from their elaſticity, and partly from their muſcularity, re-act on the blood, which, meeting with the leaſt reſiſtance, muſt paſs towards their extremities. By theſe means, the blood is continued in its progreſs, till its return by the veins. But it muſt have anſwered its particular purpoſe in the circulation before its return to the heart. Every part

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* New Syſt. Anat. pag. 436.

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* Prim. lin. par. 193.

muſt be ſupplied with its proper nouriſhment, every gland with the matter fit to form its ſecretion, every ſurface lubricated with its proper fluid, and the unneceſſary and feculent portions ſeparated. If the exhalants are directly continued from the arteries, they muſt participate in their action, and muſt receive ſuch parts of the blood, as can be forced into them by their contraction. The diameters of theſe veſſels being too ſmall to admit the red blood, if the action of the heart and arteries be moderate, the fluid propelled into them will be the thinner part of the blood, as the aqueous, and a portion of the ſaline parts of the *ſerum*, together with ſuch particles as are capable of receiving an ærial form, and may be neceſſary to be eliminated from the ſyſtem.

Part of the fluid which is thus emitted, will be ſucked up by the abſorbent veſſels, which ariſe from the ſurface, part of it will be imbibed by the clothes, where they are applied to the body; part of it will be diſſolved by the air, from ſuch parts as it comes in contact with; part of it will be diſſolved in the gaſſes that are emitted; and if the quantity diſcharged ſhould be greater than what the abſorbents can ſuck up, and the æriform fluids diſſolve, then will an accumulation of it take place in ſuch parts as are not touched by the clothes, or to which the air has no acceſs, as frequently happens, between the toes and other receſſes of the body. But when the force of circulation is greater, more fluids will be forced into the exhalants, and thus the quantity of perſpired matter will be increaſed. If it be more than the cauſes already aſſigned for its removal can diſſipate, it will remain in a viſible form on the ſkin. Thus, then, the inſenſibly perſpired watery fluid, is that which is diſſolved by the air and the gaſſes emitted from the ſkin; while the ſweat is the ſaline, oily or mucous parts which remain, unabſorbed, or is imbibed by the clothes.

On this principle, we can account for the appearance of ſweat from the operation of internal ſtimuli, or from exerciſe. For by increaſing the rapidity of circulation, the ſucceſſive portions of fluid are more frequently brought to the ſurface, and diſcharged.

In the ſame manner we can explain the profuſe ſweats, which ſucceed the hot fit of fevers, particularly thoſe of the intermittent type. In the cold ſtage, the blood leaves the cutaneous veſſels, retiring towards the inner parts of the body, as appears by the paleneſs and ſhrinking of the muſcles of the face, the ſhriveling of the ſkin, and the drying up of ulcers.* It therefore, collects in unuſual quantity about the heart and the veſſels in its neighbourhood. The heart being thus preternaturally diſtended, contracts with greater force, and propels the blood again towards the ſurface of the body ; but the veſſels of that part having, by the previous receſſion of the blood, loſt an accuſtomed ſtimulus, become more irritable, ſo that when the blood is again driven towards them, their ſides are excited to contract, become more denſe, and their diameters are leſſened ; nay, perhaps, they may be rendered quite impervious ; and thus they afford one obſtacle to the paſſage of the blood into them. But the force of the heart and arteries being greater than this reſiſtance, they, through repeated exertions, dilate the cutaneous veſſels, a certain ring or portion of the artery being diſtended by each ſucceeding impulſe, until at length they are filled with more than their uſual quantity, and pour out a preternatural quantity of ſweat. And this will continue until the violent action of the heart and arteries becomes leſſened, from the ſtimulus which cauſed it ceaſing equally to excite it. Hence, the quantity of fluid diſcharged will gradually become leſs, and will at laſt diſappear. As the ſweat continues to flow, the heat of the body, from the conſtant evaporation which takes place, will be gradually diminiſhed, and will at laſt return to its uſual temperature.

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* Cullen's Firſt Lines.

I am aware, that other explanations have been offered for the appearance of ſweat in fevers. But this appears to me the moſt ſatisfactory. *Dr. Darwin aſſerts, that the perſpirable matter is ſecreted in as great quantity, during the hot fit as afterwards, when the ſweat is obſerved on the ſkin; but that during this ſtage, the cutaneous abſorbents acting with greater energy, and the exhalation being augmented by the increaſed temperature of the ſkin, the fluid does not remain on the ſurface, but is in part re-abſorbed, and in part diſſipated in the air. And he aſcribes the after appearance of ſweat, to the action of the abſorbent veſſels being leſſened by the application of cool air, or cold bed clothes.

The doctor, however, has taken for granted what has not any where been demonſtrated. †"The heat in fevers," ſays he, "ariſes from the increaſe of ſome ſecretion." Hence the increaſe of perſpiration, which by him is conſidered a ſecretion, produces an increaſe of heat; for increaſed ſecretion "is always attended with an increaſe of local, or "general heat." But as the temperature of the ſecretions has never, by any experiment, been aſcertained, this aſſertion cannot be admitted.

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* Zoonom. part ii. pag. 20.

† Ibid. pag. 19.

mitted. Chemical changes are, to be ſure, always attended with a change of temperature; but it does not follow, that it muſt be an increaſe of temperature; for they are certainly ſometimes followed by a diminution of temperature. The principle, then, that the heat of the ſkin in fever depends on increaſed perſpiration, is without foundation. On the contrary, the heat muſt be diminiſhed by perſpiration, for a great part will, as he has ſuppoſed, be carried off by the air; and the ſolution of any fluid in air is attended with a diminution of temperature. Nor can the non-appearance of ſweat in the hot ſtage, be attributed to the greater abſorption from the ſkin; for although it be admitted, that the action of the abſorbents is increaſed in proportion to that of the ſecerning ſyſtem, yet the abſorption will be prevented, as may be ſhewn from his own principles. For "when the ſanguiferous ſyſtem is "full of blood, the abſorbents cannot act ſo "powerfully, as the progreſs of their contents "will be oppoſed by the previous fulneſs of "the blood veſſels." If ſweat, therefore, were to take place during the hot fit, while the veſſels of the ſkin are unuſually diſtended, as appears from the great fulneſs and turgeſcence of every external part, as it could not be readmitted through the abſorbents, and part of it only being diſſolved by the air, it would eaſily be obſerved.

The opinion, that ſweat becomes viſible in conſequence of the diminution of temperature, which before prevented it, is further rendered improbable, by perſons frequently paſſing from the hot to the ſweating ſtage, without being expoſed to cooler air, or a change of bed clothes. The fact derived from Mr. Alexander's experiments, viz. that ſweat does not appear until the heat of the ſkin has fallen from 112° to 108°, does not here apply. For from his experiments it appears, that when the temperature is increaſed by the artificial application of external heat, beyond the boundary of health, ſweating is prevented. In this caſe, from the power of the ſtimulus, the capillaries are exceſſively excited, and hence conſtricted, until, by the application of cold, an abſtraction of heat takes place, and a conſequent diminution of excitement, when the cutaneous veſſels become again dilated, and the ſweat begins to flow. But in fever, the temperature of the body never becomes ſo exceſſive, and the heat of the ſkin never ſurpaſſes ſo far that of the internal parts; and as the heat of the ſkin is derived from the conſtant influx of the blood into its veſſels, its temperature cannot be leſſened before the commencement of perſpiration, as there is no other cauſe of alteration.

The explanation, therefore, before given, appears to me, the only proper or ſatisfactory one that can be offered, of the "warm ſweats," or thoſe which ſucceed fevers.

On the ſame principles are to be explained the profuſe colliquative ſweats, which take place in that exhauſted ſtate of the ſyſtem, which precedes death, and is conſequent on fevers of the continued form. In theſe the action of the ſanguiferous ſyſtem, together with the exceſſive operation of heat, contribute finally to exhauſt the extreme veſſels, which from the debility thus induced, are no longer capable of permanent contraction, but become expanded, and permit the fluids, which are ſtill continuing to be ſent to them, to be diſcharged on the ſkin. But as the action of the abſorbents is, at the ſame time, diminiſhed with the reſiſtance of the capillaries, they will imbibe leſs than uſual; and thus the ſweat will be accumulated on the ſurface.

As the heat of the body is diminiſhed by the evaporation from its ſurface, and the accumulation of it prevented by the inaction of the veſſels; the ſweat which ſtands on the ſurface, will convey to a perſon the ſenſation of cold. The viſcidity of ſweats in ſuch caſes, may be owing to the watery part being diſſipated in the air, while the oily and coagulable parts remain unabſorbed; perhaps alſo ſome other parts will be diſcharged, from the little reſiſtance of the exhauſted capillaries.

A different opinion reſpecting cold ſweats, has been offered by Dr. Darwin, who calls to the aid of his theory, his favorite hypotheſis, the retrograde action of the abſorbents. But upon examination, it will be found, that his theory on this ſubject, as well as the principle on which it depends, are more ingenious than true. The lymphatics are univerſally known to anatomiſts, to be ſupplied, at very minute diſtances, with valves, which, from their ſituation, muſt be intended to prevent the regurgitation of their contents. This cannot, therefore, take place, unleſs the fluid be driven back with ſuch violence as to force or tear the valves. But in order to get over this difficulty, he obſerves, that, * "as theſe valves are placed in veſſels "which are endued with life, and are them"ſelves endued with life alſo; and are very "irritable into thoſe natural motions, which "abſorb or propel the fluids they contain, it "is

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* Zoonom. part i. ſect. 29. 2.

"is poſſible, in ſome diſeaſes, when theſe
"valves or veſſels are ſtimulated into unnatural
"exertions, or are become paralytic, that du-
"ring the diaſtole of the part of the veſſel to
"which the valve is attached, the valve may
"not ſo completely cloſe, as to prevent the
"relapſe of the lymph or chyle." And he adds, that this is rendered probable, by injections of mercury, water, &c. eaſily paſſing the valves, contrary to the natural direction of the fluids. That theſe veſſels, as well as their valves, are endued with life, will not be doubted; but that they are poſſeſſed of that degree of action which he ſeems to aſcribe to them, is, I believe, not allowed by all. Some have attributed their power of abſorption to capillary attraction; but whether their functions as veſſels are to be referred to this, or to a contractile power inherent in them, has not yet been ſufficiently aſcertained. But admitting them to poſſeſs a natural capacity for action, it is ſcarcely probable that their action could become ſo exceſſive. And ſuppoſing the ſtrength of the valves proportioned to that of the veſſels, as they are known to be exceedingly tender, an extravaſation would ſeem as apt to take place as a regurgitation. That this ſhould be cauſed by a paralyſis of the veſſels, appears ſtill more improbable; for as in this caſe, the veſſels are unable to act, to ſuppoſe a return of the fluid from this ſource, would

would be admitting an effect without a cauſe. The doctor has alſo made uſe of ſeveral analogies with other veſſels, to prove the point in queſtion, but they do not ſeem ſtrictly to apply. He has ſuppoſed it from the regurgitations of the contents of the ſtomach and lacrymal ſack, and the receſſion of the blood in the capillary veſſels. But the analogy here cannot be admitted; for the ſtomach, although its orifices have generally been ſaid to perform the offices of valves, cannot be conſidered as poſſeſſing them. Beſides, the number, ſtrength, and rigidity of its muſcular fibres, together with the functions which it is intended to perform, render it very diſſimilar The lacrymal ducts and capillary veſſels, have never been ſuppoſed to contain valves, and therefore will the more eaſily permit a retrograde motion of their fluids, when a cauſe affects them. He has mentioned but one fact, that would ſeem to ſtrengthen, in any degree, his theory. He * "tied the neck and ureters of a "freſh ox's bladder, and made an opening at "the fundus of it; then having turned it in-"ſide outwards, filled it half full with water, "and was ſurpriſed to ſee it empty itſelf ſo "haſtily." But no proof, in my opinion, is derived from this experiment, for although the bladder was found to empty itſelf, it does not follow

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* Zoonom. part i. ſect. 29. 2.

follow it did ſo by the paſſage of the water through the lymphatics. The bladder is plentifully ſupplied with blood veſſels, which alſo paſs on to it, from its neck, and by their ſeparation with the bladder from the body, will afford as ſpeedy a paſſage as the one ſuppoſed.

If a lymphatic be compreſſed, by the action of muſcles or the preſſure of any body external, the contained fluid retiring from the force, will eſcape at that part where it meets the leaſt reſiſtance, and will conſequently be forwarded towards its deſtination. The idea, then, of the regurgitation of the abſorbed fluids, ſeems merely fanciful, and the explanation of any effuſion from this cauſe entirely unfounded.

2d. The origin of the æriform ſubſtances perſpired, cannot ſo eaſily be aſcertained. The experiments on this ſubject have only diſcovered the quality of the air emitted ; its ſource remains yet for further inveſtigation. We know, however, that the blood is conſtantly undergoing a change in the lungs, by a particular proceſs which takes place there, probably ſimilar to combuſtion. Carbonic gas, in this caſe, is emitted from the lungs, whether formed there or exiſting in the blood. The latter opinion is embraced by ſome, though the former is moſt generally adopted. I may venture, however, on an hypotheſis, that, as the union of oxygen is believed, its combination with carbone in the blood may be the origin of the gas that is emitted from the ſkin. The exiſtence of azot, in the blood, and moſt animal ſubſtances, has been demonſtrated by numerous experiments; but in what manner, or by what proceſs, its ſeparation is produced, muſt be left for future facts to determine. Little, therefore, can at preſent be with certainty ſaid, as to the origin of the ærial diſcharge.

V. Having now conſidered the qualities, as well as the quantity and production of the matters which conſtitute the perſpirable diſcharge, as far as could be aſcertained from the experiments and facts related by different writers, I ſhall next proceed to the conſideration of the queſtion, Whether the retention of the perſpirable matter, is ever productive of derangement in the ſyſtem?

Sweat, before the knowledge of the inſenſible diſcharge, was conſidered by the humoral pathologiſts, as an excrementitious fluid, neceſſarily ſecerned from the ſyſtem, and productive of diſagreeable and dangerous conſequences, if retained in it. That this, even in the infancy of the medical art, was conſidered as a cauſe of diſeaſe, appears from an aphoriſm of Hippocrates: "Ubi in corpore ſudor, ibi mor-"

"bus." The moſt natural inference we could draw from this ſentence, would be his belief in the retention of the perſpirable matter as injurious to the health of the body; for its preſence in a part he conſiders a ſymptom of diſeaſe. The idea of morbific matter, as produced by a putrefactive fermentation in the blood, together with the fetid odour given out by ſweat, in ſome diſeaſes, led, probably, to the belief of its eſcape through this channel, as the moſt natural for its elimination from the ſyſtem. To a ſuppreſſion of perſpiration then, were moſt diſorders of the human body attributed. Morbific matter, by being retained, was carried back into the blood veſſels, producing general affections, or by being confined to a part, gave origin to many local diſorders. Hence proceeded eryſipelas, herpes, and the ſeveral affections of the lungs and trahea.

Dr. Darwin, however, and ſeveral who have embraced his opinions, have rejected the notion of the ſuppreſſion of this diſcharge having any ſhare in the production or criſis of diſeaſes. He has endeavoured to ſhew, from the practices among many nations of anointing with oil,* of the faſhion of painting, and the uſe of powder and pomatum among ourſelves, that perſpiration may be checked without injury. This may be, in a great meaſure, true; but the uſe of oil, and the other ſubſtances with which the body is ſometimes ſmeared, does not entirely prevent the diſcharge of perſpirable matter; for on increaſed exerciſe, the pores, tho', covered, are forced frequently by a copious flow of ſweat. Were this not the caſe, the poſition would be in a greater degree eſtabliſhed.

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* Zoonom. part ii. pag. 24.

The operation of cold on the body, in producing diſeaſe, has been entirely attributed to the change produced in the living fibres,* and not to an obſtruction of perſpiration. This effect of cold will immediately be granted; but ſtill the obſtruction may have a conſiderable ſhare in the operation. For by leſſening the evacuation, a quantity of fluid will be retained, which quantity will be greater in proportion to the increaſe of exerciſe or temperature. This, therefore, will be an additional ſtimulus to thoſe which are afterwards applied, and will conſequently aſſiſt in throwing the ſyſtem into violent action, which, by its force, will overcome the reſiſtance of the cutaneous veſſels, which, from their previous quieſcence, and the preſent ſtimulus, muſt be exceſſively excited; or by exciting fever, call for evacuations of a different kind. It is aſſerted, however, that the diminution of this is followed by the increaſe of another diſcharge. This will generally be admitted, but the increaſed evacuation is not always ſufficient to counterbalance that which is checked; yet if it was, another part being obliged to make a greater exertion than that for which it was naturally deſtined, will neceſſarily be injured, and the greater and more permanent will that injury be, the greater the ſenſibility of the organ affected, and the longer the continuance of the cauſe which produced it. Thus, the inteſtines will ſuffer more than the kidneys, and the ſtomach more than the inteſtines. If the part affected be very important, the whole conſtitution will be proportionably deranged. As, for inſtance, ſuch an affection will injure digeſtion, and hence, dyſpepſia and the diſeaſes conſequent on an imperfection in this function. An affection of the inteſtines will give riſe to colic, diarrhoea, cholera and dyſentery. Theſe diſeaſes may frequently be referred to a determination to the bowels from ſuppreſſed perſpiration.

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* Med. Repoſ. Vol. ii. No. 1. Art. 13.

With the effects of a ſuppreſſed perſpiration, in producing catarrh, we are ſufficiently acquainted. That it is checked during the inflammatory ſymptoms of this affection, I think evident from what has been already ſaid of it in the hot ſtage of fevers, and tho' the other parts of the body ſhould be obſerved to perſpire, the exceſſive action in the part affected, would prevent its appearance there.

The concluſion I ſhall therefore conſider juſt, that the regular operations of this function cannot be arreſted very ſuddenly, without creating ſome derangement. I ſhall now cloſe the diſſertation, without enlarging on what has been ſaid, or attempting to explain the operation of thoſe articles, the effects of which, as ſudorifics, muſt be known to all.

> ———*Si quid noviſti rectius iſtis*
> *Candidus imperti.*——— HORAT.

And now, before I take leave of the ſubject entirely, I would wiſh the Profeſſors to accept my ſincere thanks for the inſtructions I have received from their lectures, and the many opportunities of improvement I have experienced thro' them, while a ſtudent in this Univerſity.

To Dr. Wiſtar I am particularly indebted, for the obſervations and inſtructions with which he has favoured me, both on this and numerous other ſubjects, and for ſeveral valuable caſes in his private practice of ſurgery, with the inſpection

tion and knowledge of which he was kind enough to indulge me. For theſe, and his polite attention to me during my reſidence in this place, I beg he will accept my grateful acknowledgements, and be aſſured of my faithful remembrance.

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